(19) Europäisches Patentamt
European Patent Office
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(11) EP 0 826 995 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
04.03.1998 Bulletin 1998/10

(51) Int. Cl.[6]: **G02B 6/42**

(21) Application number: **97109882.7**

(22) Date of filing: **17.06.1997**

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: **28.08.1996 US 705874**

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(54) An optoelectronic module having its components mounted on a single mounting member

(57) A photonics apparatus is described. All of the components of the photonics module (30) are precisely mounted and aligned on a single mounting member (31) without requiring active alignment and additional mounting members. The components mounted on the mounting member (31) include at least a laser (39), a photo detector (32), and two sperical lenses (33,34). The components may also include an optical filter (36) and a mirror (35). A photo-lithographic masking and etching process can be used to precisely process the silicon mounting member to mount these components. Pyramidal cavities etched in the mounting member are used to hold the spherical lenses in a manner to avoid light beam abstraction. The photo detector (32) includes an integrated mirror and its active area is parallel to the surface of the mounting member. The optical filter and the mirror may be integrated together to form an integrated device that is attached to the mounting member. A method of making the photonics apparatus is also described.

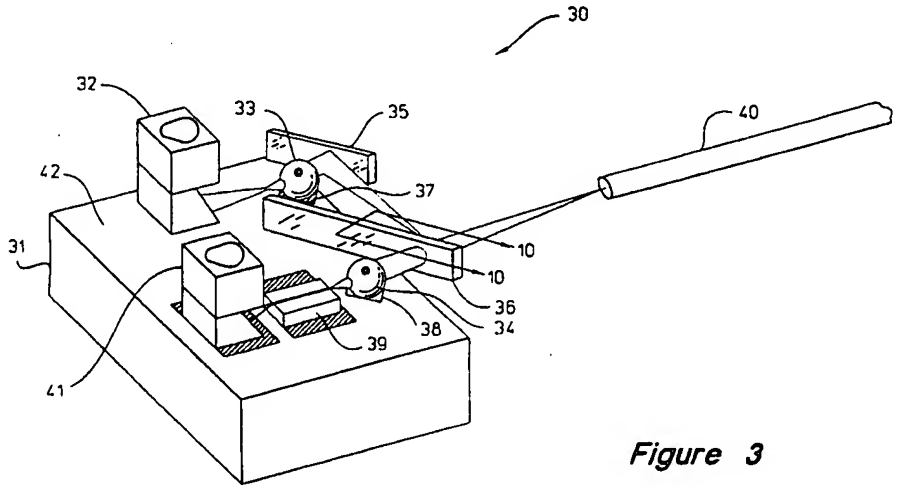

Figure 3

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cisely defined. When the optical filter 36 is mounted in the groove 121, the optical filter 36 is also precisely mounted and aligned on the mounting member 31.

As described above, because the mounting member 31 is made of (100) silicon, the V-shaped groove 121 is defined on the mounting member 31 using photolithographic masking. The groove 121 is then formed using anisotropic etching such that side walls (e.g., the side walls 123 and 124) of the groove 121 lie on the (111) crystallographic planes of the silicon mounting member 31. This causes the side walls 123-124 to intersect the top surface of the mounting member 31 at approximately 54.7° because the (111) planes intersect the (100) surfaces of the mounting member 31 at approximately 54.7°. The V-shaped end 121 of the optical filter 36 can be formed by two saw cuts using, for example, dicing saw. Alternatively, the V-shaped end 121 can be formed by other known means.

If the optical filter 36 is to be vertically mounted on the mounting member 31, then the V-shaped end 121 is formed by two 54.7° symmetrical cuts. If the optical filter 36 is to be tilted on the mounting member 31, then the V-shaped end 121 is formed by two asymmetrical cuts at two different angles. Alternatively, other mounting arrangements can be employed to mount the planar optical filter 36. These other mounting arrangements are shown and described in more detail in the co-pending application no. , entitled MOUNTING A PLANAR OPTICAL COMPONENT ON A SEMICONDUCTOR MOUNTING MEMBER, filed on the same date as the present application, and assigned to the same assignee of the present application.

Figure 11 shows an arrangement of mounting or integrating the components of a photonics module 140 on a single mounting member 141 which implements an alternative embodiment of the arrangement of Figure 3. As can be seen from Figures 3 and 11, the arrangement of Figure 11 is identical to that of Figure 3, except that the optical filter 146 of Figure 11 is aligned and fixed by the spherical balls 148-149 and the spherical lens 144. In addition, the photonics module 140 of Figure 11 does not have any mirror. Figure 12 is a top view that shows in more detail how the optical filter 146 is secured by the spherical lens and balls 144 and 148-149. Figure 12 also shows a push ball 155 that helps secure the optical filter 146 on the mounting member 141. The spherical lens and balls 144 and 148-149 are placed on the mounting member 141 to define a geometrical plane 153. The planar optical device 146 is then placed on the mounting member 141 against each of the spherical balls 144 and 148-149 such that the planar optical device 146 is placed along the defined geometrical plane 153. This allows the planar optical device 146 to be precisely mounted on the mounting member 141. Glue or other adhesives are then applied to bond the optical filter 146 to the mounting member 141. Again, this arrangement is shown and described in more detail in the co-pending application no. , entitled MOUNTING A PLANAR OPTICAL COMPONENT ON A SEMICONDUCTOR MOUNTING MEMBER, filed on the same date as the present application, and assigned to the same assignee of the present application.

Figure 13 shows another arrangement of mounting or integrating the components of a photonics module 170 on a single mounting member 171 which implements another alternative embodiment of the arrangement of Figure 3. As can be seen from Figures 3 and 13, the arrangement of Figure 13 is identical to that shown in Figure 3, except that the optical filter 182 and the mirror 183 of Figure 13 are integrated into a single optical device 177 which is then attached to a side surface 185 of the mounting member 171. By integrating the optical filter 182 and the mirror 183 into the single optical device 177, the distance between the mirror 183 and the optical filter 182 is precisely defined. In addition, the integration allows alignments of the optical filter 182 and the mirror 183 with respect to other optical elements of the photonics module 170 to be precisely predefined. Moreover, the integration also allows the integrated optical device 177 to be fabricated at low cost using batch processing. The integrated optical device 177 and the process of fabricating the device are described in more detail in the co-pending application no. , entitled FABRICATING AN OPTICAL DEVICE HAVING AT LEAST AN OPTICAL FILTER AND A MIRROR, filed on the same date, and assigned to the same assignee of the present application.

In the foregoing specification, the invention has been described with reference to specific embodiments thereof. It will, however, be evident to those skilled in the art that various modifications and changes may be made thereto without departing from the broader spirit and scope of the invention. The specification and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense.

Claims

1. A method of making a photonics apparatus (30, 140, 170), comprising the steps of:

   (A) forming a first and a second cavity (37, 38, 178, 179) with sloping side walls in a mounting member (31, 141, 171);
   (B) mounting a laser (39, 145, 175) on the mounting member (31, 141, 171) such that an optical axis (71) of the laser (39, 145, 175) is aligned with a diagonal of the first cavity (37, 178);
   (C) placing each of a first and a second spherical lens (33, 34, 173, 174) in one of the first and second cavities (37, 38, 178, 179);
   (D) providing an integrated device (80) having a surface-detecting photo detector (81) and a

mirror (85) facing an active area (82) of the photo detector (81);

(E) mounting the integrated device (80) on the mounting member (31, 141, 171) with the active area (82) of the photo detector (81) parallel to a top surface of the mounting member (31, 141, 171) and the mirror (85) facing a diagonal of the second pyramidal cavity (37).

2. The method of claim 1, wherein the mounting member (31, 141, 171) is made of silicon and the steps (A), (B), and (E) are performed using a photo-lithographic masking and anisotropic etching process.

3. The method of claim 1 or 2, further comprising the step of forming a groove (120) on the mounting member (31, 141, 171) to mount a planar optical element (36, 146, 153) that can be one of an optical filter and a mirror (35, 36).

4. The method of claim 1, 2, or 3, further comprising the steps of:

placing a plurality of spherical positioning balls (144, 148, 149, 155) on the mounting member (141) to define a geometrical plane;
placing a planar optical element (146, 153) against each of the plurality of spherical positioning balls (144, 148, 149, 155) such that the planar optical element (146, 153) is placed along the defined geometrical plane.

5. The method of claim 4, further comprising the step of forming a plurality of pyramidal cavities in the mounting member (141) for seating the plurality of spherical positioning balls (144, 148, 149, 155).

6. The method of any one of the preceeding claims 1-3, further comprising the steps of

forming an integrated optical device (177) having at least one optical filter (182) and one mirror (183) spaced apart at a predefined distance that corresponds to the predetermined distance between the first and second pyramidal cavities (178, 179);
attaching the integrated optical device (177) to a side of the mounting member (171).

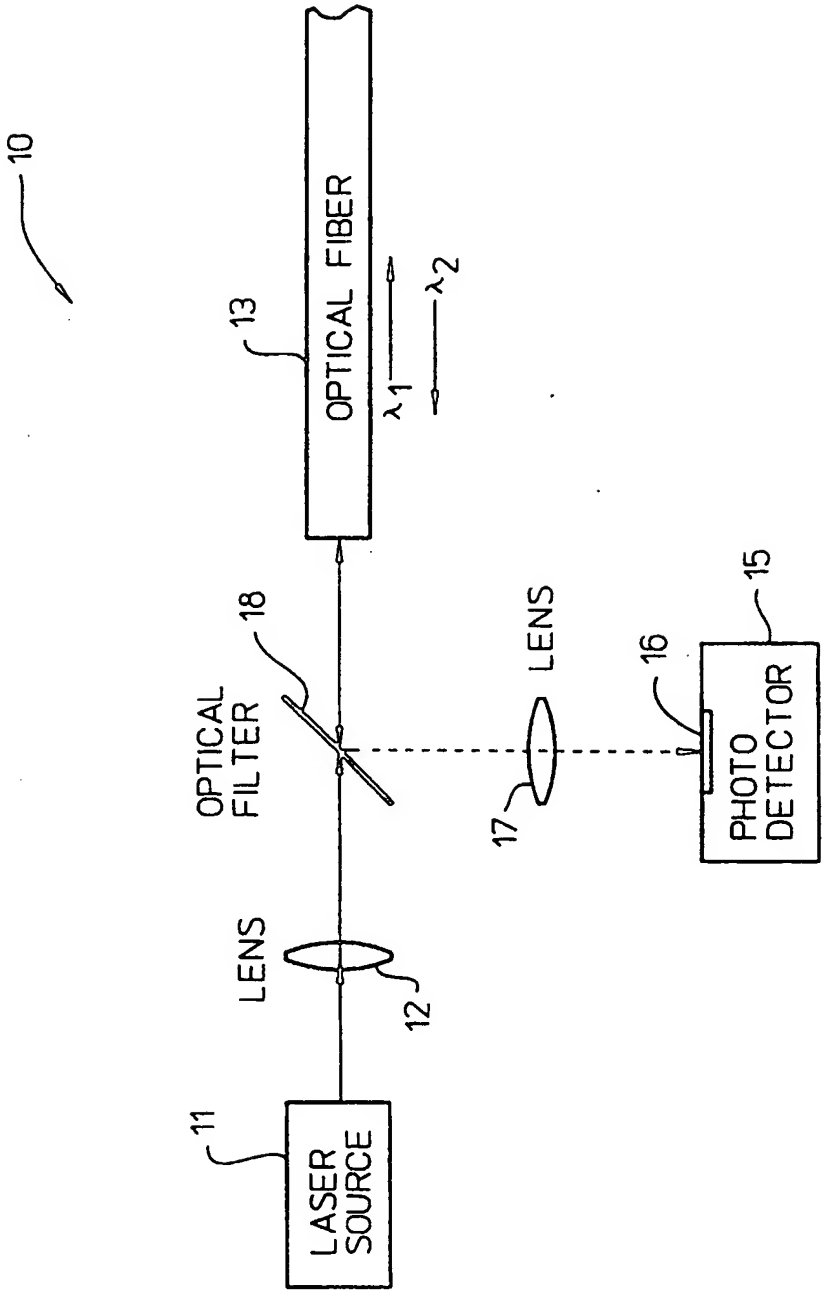

Figure 1 (PRIOR ART)

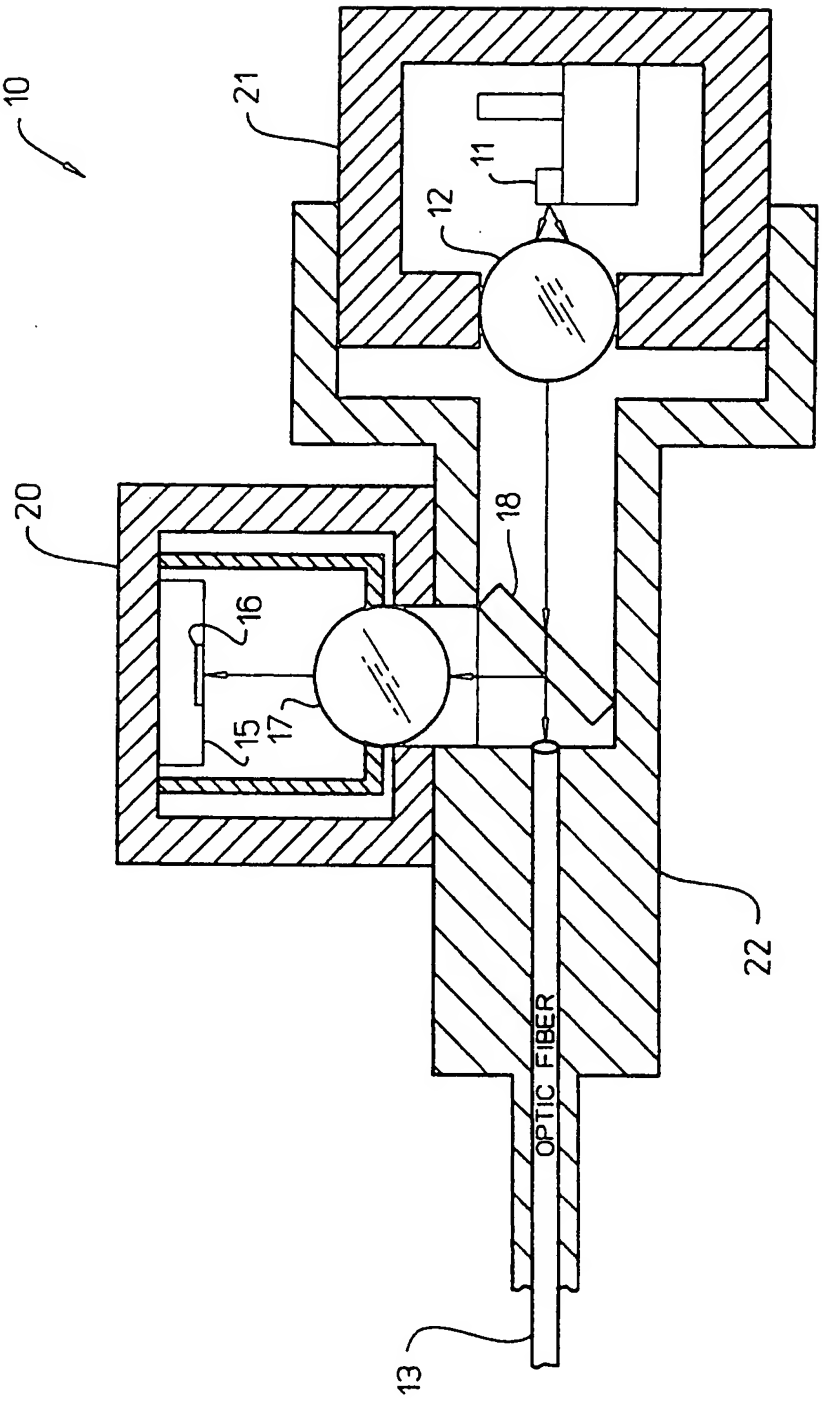

Figure 2 (PRIOR ART)

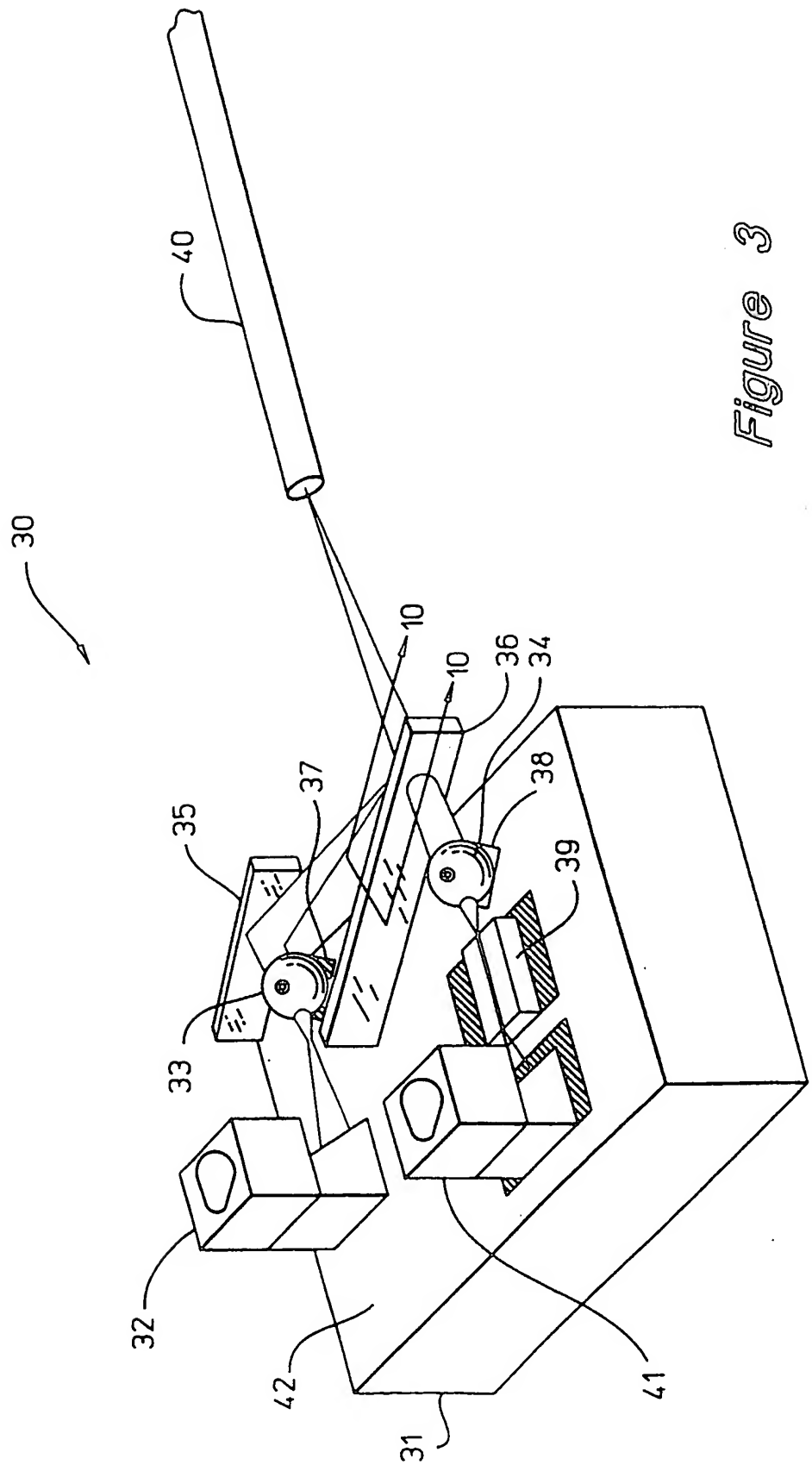

Figure 3

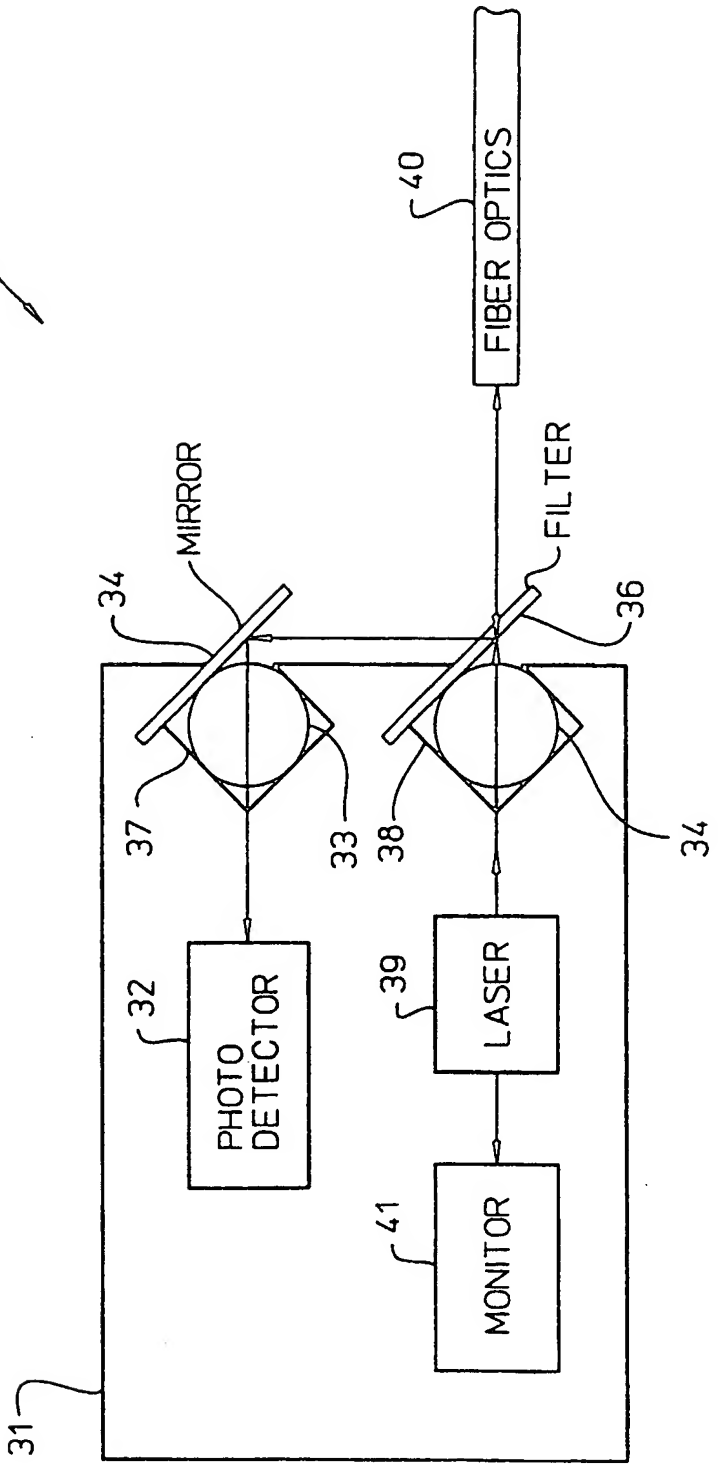

Figure 4

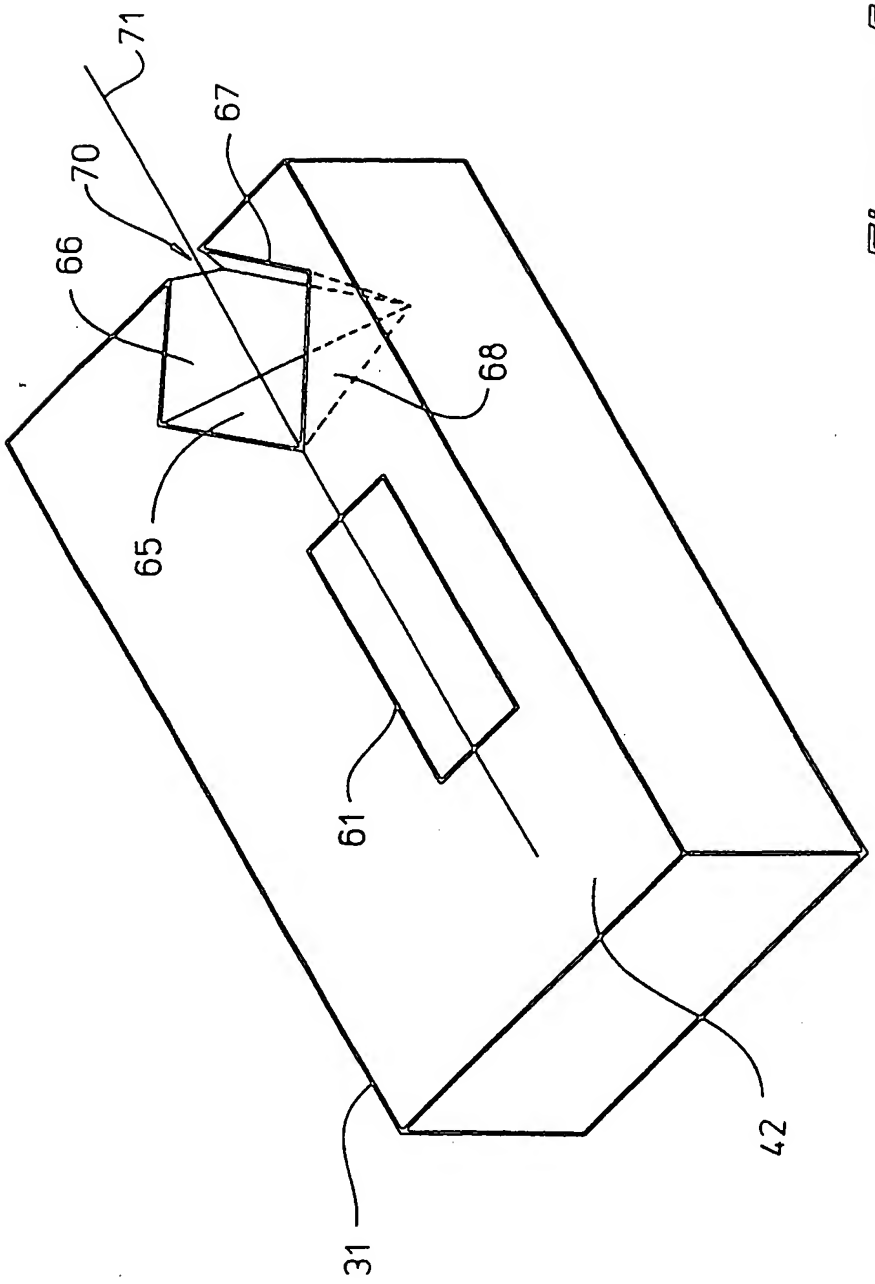

Figure 5

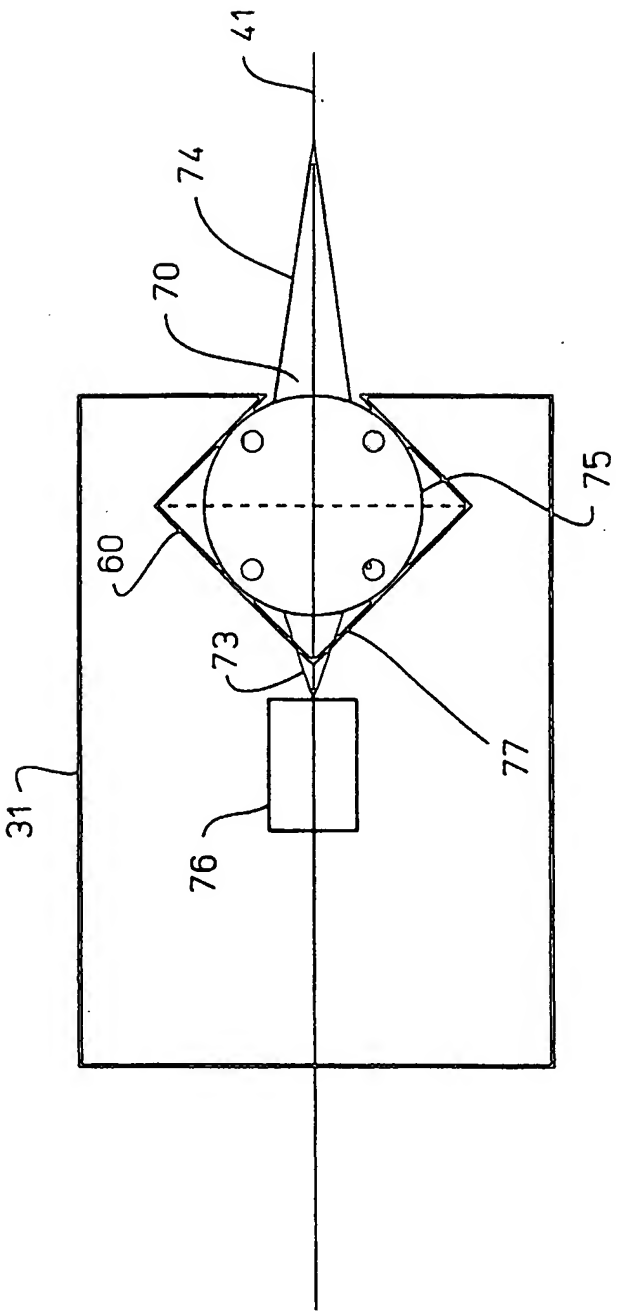

Figure 6

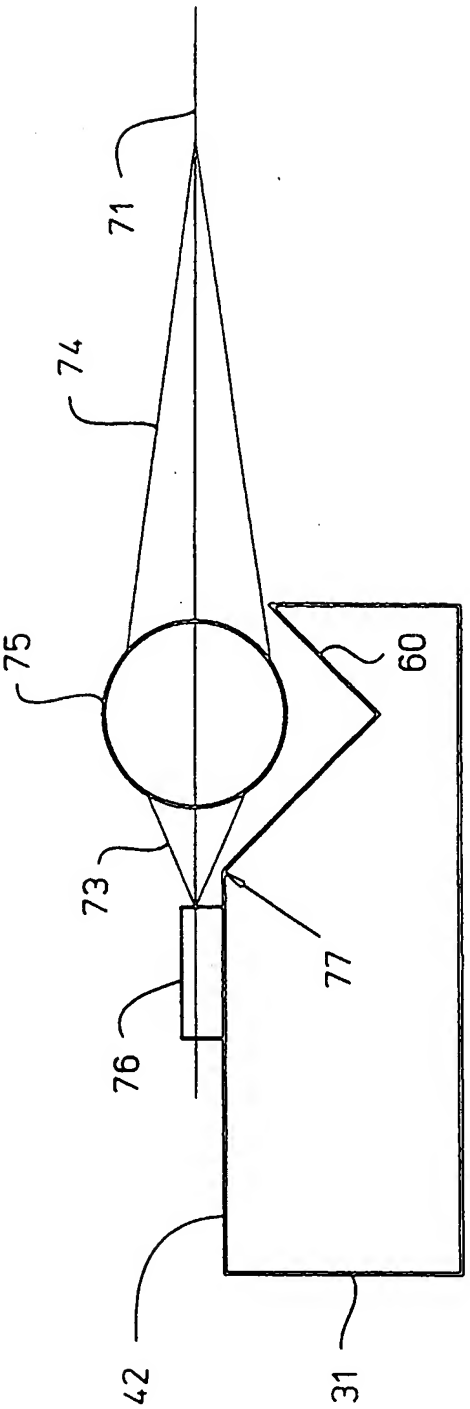

Figure 7

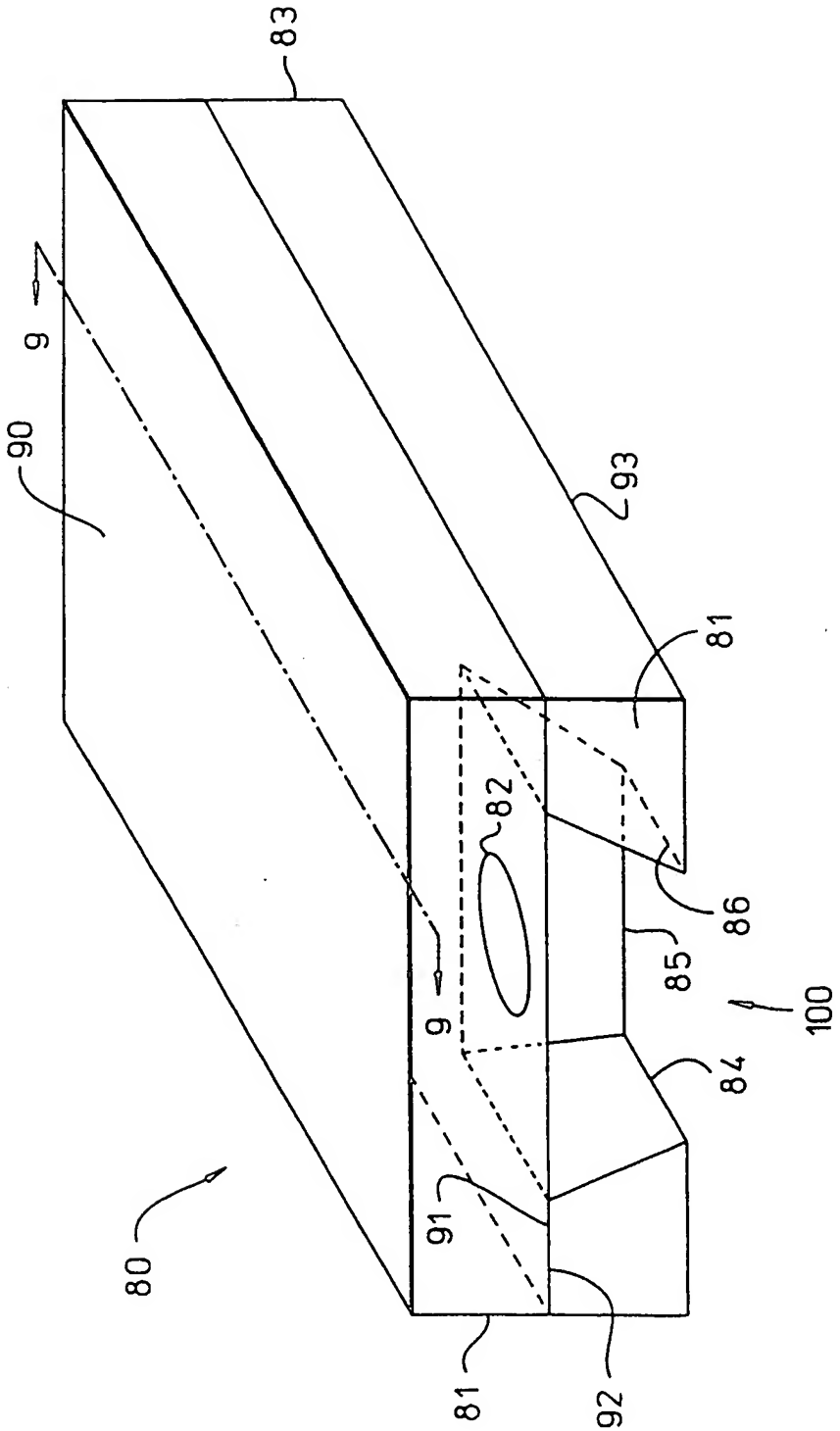

Figure 8

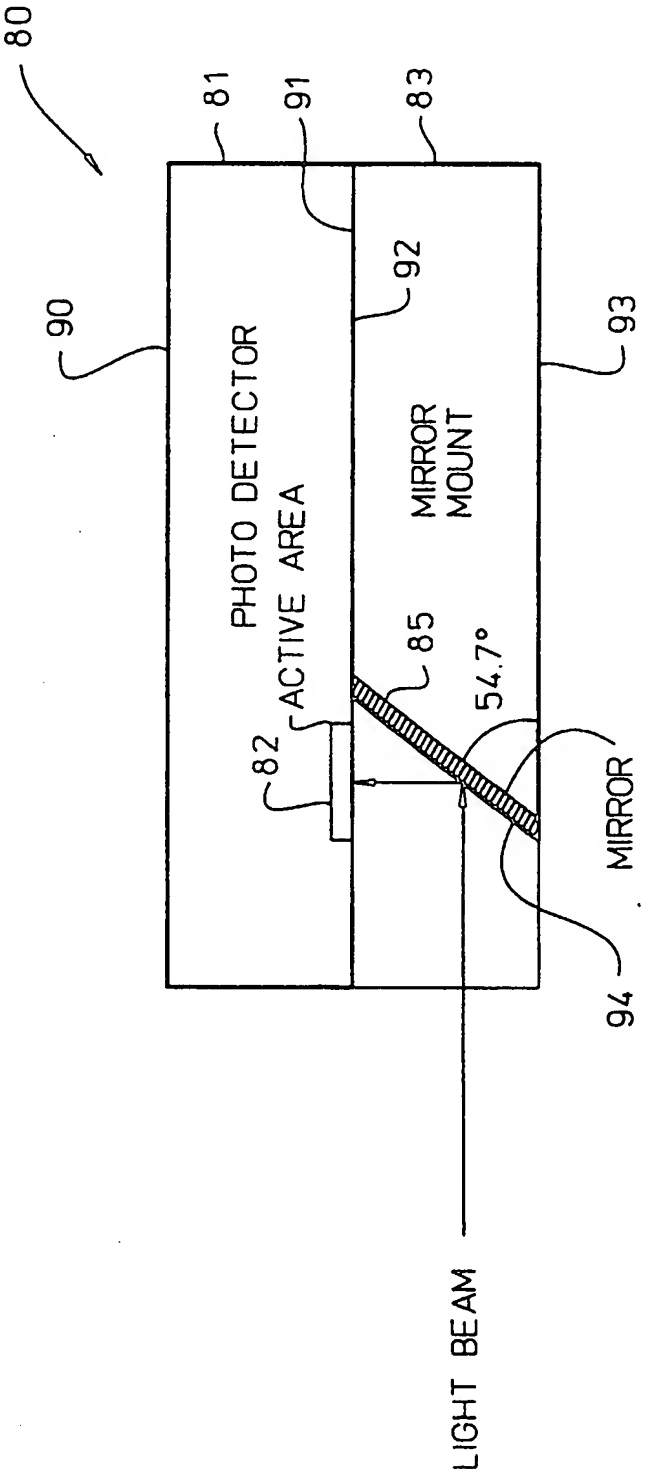

Figure 9

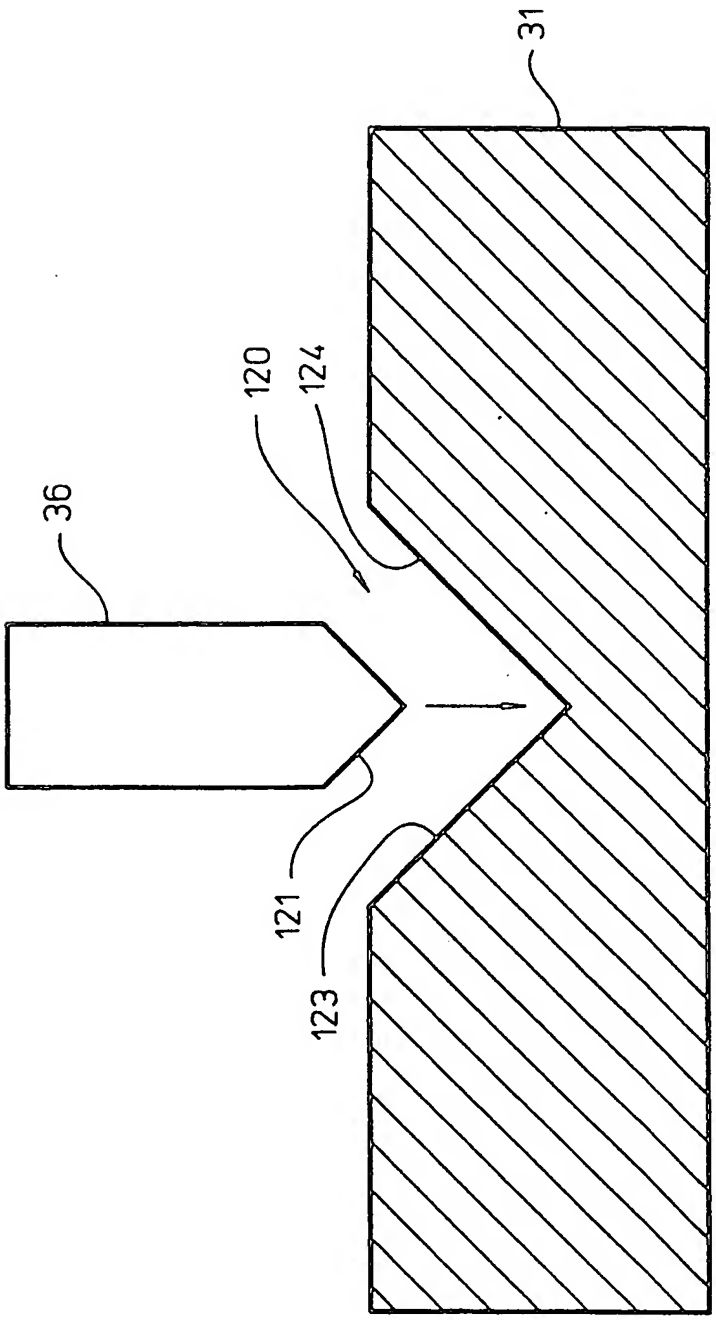

Figure 10

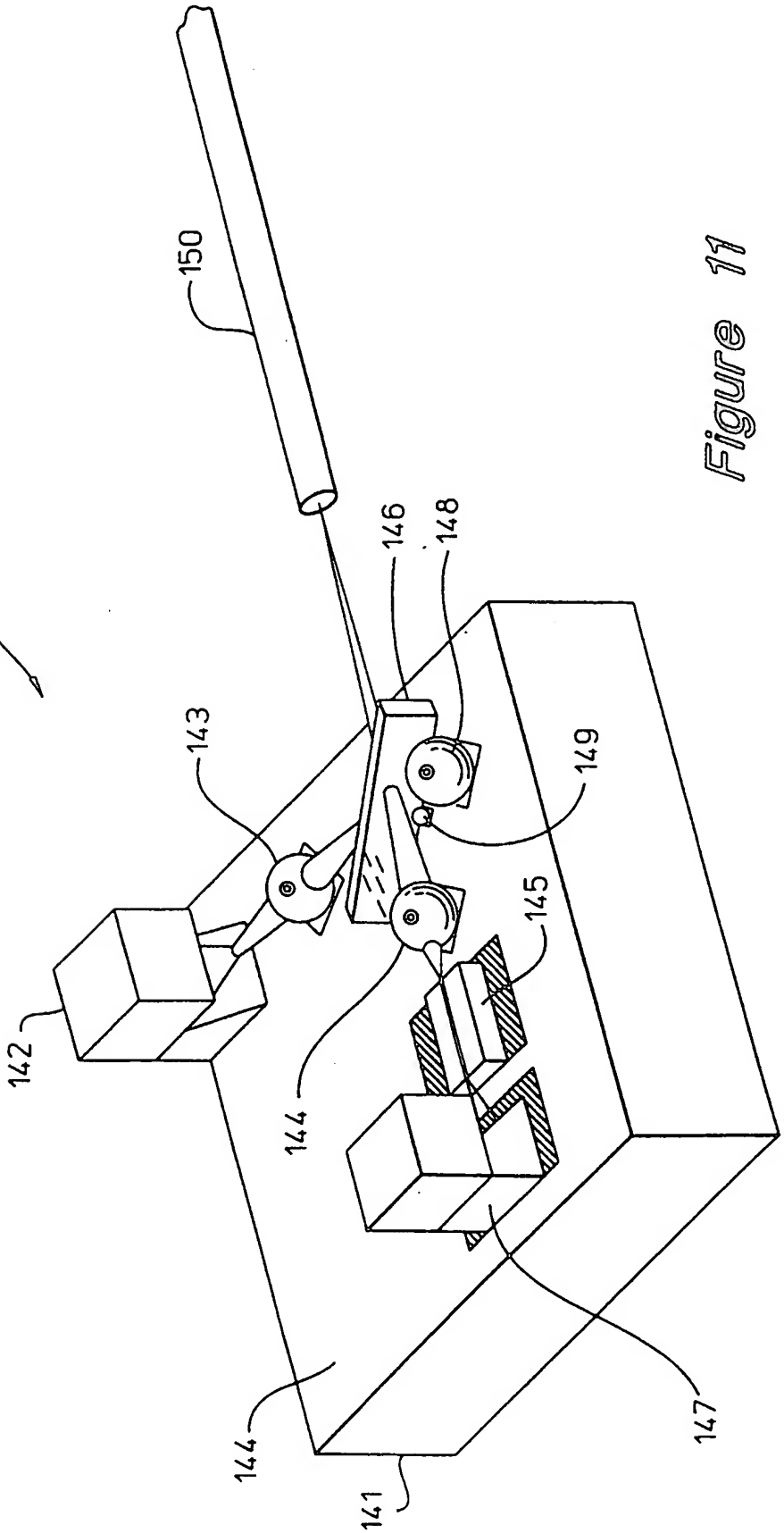

Figure 11

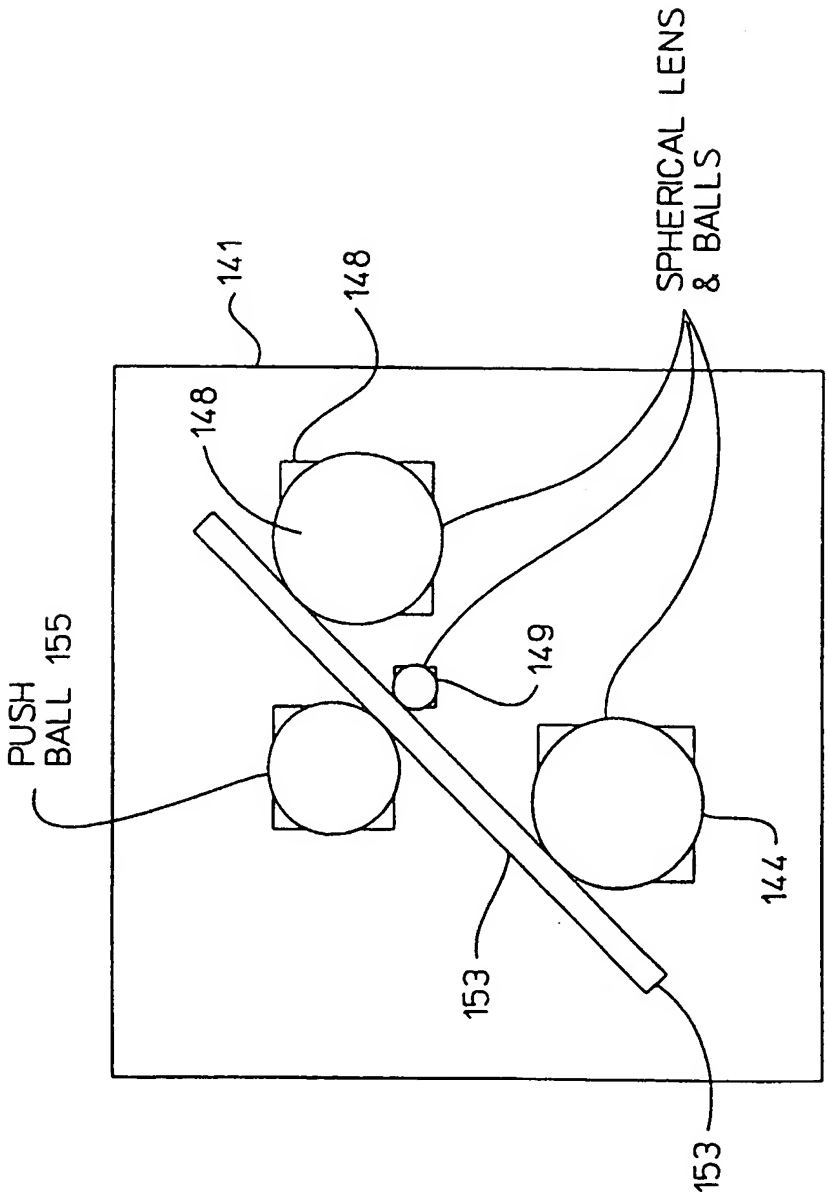

Figure 12

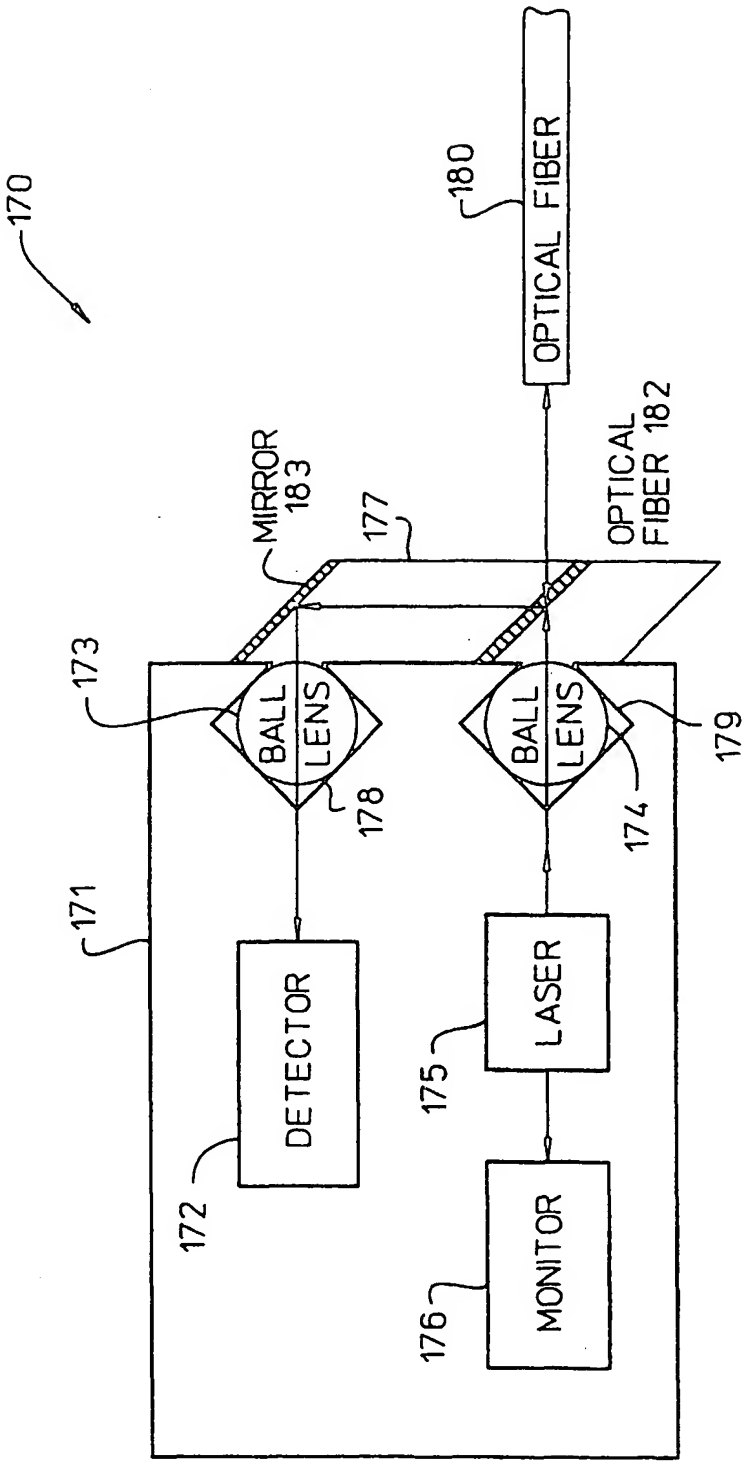

Figure 13

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 10 9882

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	DE 38 09 396 A (SIEMENS AG) 5 October 1989 * claims 1,2 * * column 4, line 25 - line 48; figures 1,5 * ---	1-3	G02B6/42
P,A	DE 195 15 688 C (BOSCH GMBH ROBERT) 26 September 1996 * column 3, line 12 - line 30; figure 3 * ---	1,2	
A	EP 0 640 853 A (FUJITSU LTD) 1 March 1995 * column 7, line 32 - line 50 * * column 8, line 36 - column 9, line 41 * * column 11, line 25 - line 28 * * figures 2,6 * ---	1-3	
A	EP 0 171 615 A (NIPPON TELEGRAPH & TELEPHONE) 19 February 1986 * page 33, line 13 - line 26; figure 11 * -----	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

G02B
H01L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	26 September 1997	Ciarrocca, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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